



(51) International Patent Classification:

G06F 3/01 (2006.01) A61B 5/00 (2006.01)

A61G 5/04 (2013.01) A61F 4/00 (2006.01)

A61B 5/06 (2006.01)

(21) International Application Number:

PCT/IB2020/057279

(22) International Filing Date:

31 July 2020 (31.07.2020)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/882,006 02 August 2019 (02.08.2019) US

(71) Applicant: **KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY** [SA/SA]; 4700 King Abdullah University of Science and Technology, Thuwal, 23955-6900 (SA).

(72) Inventors: **KOSEL, Jürgen**; 4700 King Abdullah University of Science and Technology, Thuwal, 23955-6900 (SA). **ALMANSOURI, Abdullah Saud**; 4700 King Abdullah University of Science and Technology, Thuwal, 23955-6900 (SA).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(54) Title: CONTROLLING DEVICES USING FACIAL MOVEMENTS

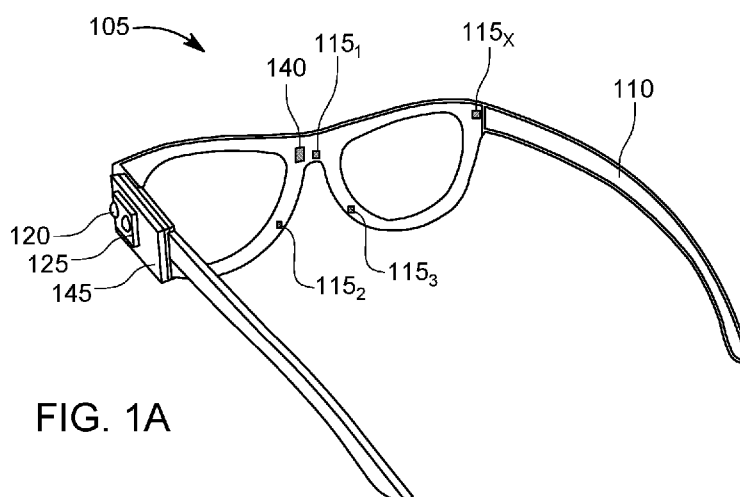


FIG. 1A

(57) Abstract: A system for controlling at least one device includes a pair of glasses having a glasses frame. A plurality of magnetic sensors, a processor coupled to the plurality of magnetic sensors, and a wireless communication transmitter coupled to the processor are arranged on or in the glasses frame. A plurality of magnetic skin tags are arranged on a human face. The plurality of magnetic sensors sense movement of at least one of the plurality of magnetic skin tags and transmit a signal corresponding to the sensed movement to the processor. The processor, responsive to receipt of the signal corresponding to the sensed movement, transmits a signal for controlling the at least one device via the wireless communication transmitter to a processor of a power-driven mobility device.

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

CONTROLLING DEVICES USING FACIAL MOVEMENTS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 62/882,006, filed on August 2, 2019, entitled "METHOD FOR FACIAL EXPRESSION TRACKING," the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

TECHNICAL FIELD

[0002] Embodiments of the disclosed subject matter generally relate to systems and methods for controlling devices, including power-driven mobility devices and devices other than power-driven mobility devices, using facial movements.

DISCUSSION OF THE BACKGROUND

[0003] Quadriplegia is a condition in which a person does not have the ability to control their arms and legs, which makes it difficult for people with this condition to live independently. These types of injuries typically occur to middle-age adults, who accordingly require lifetime solutions to allow them to interact with the world.

[0004] Due to the loss of ability to control their arms and legs, quadriplegics cannot use conventional assistive technology (i.e., power-wheel chairs operated using a joystick) to move around. Various solutions have been proposed to address this issue, including spin-n-puff, head or chin joysticks, brain-machine interfaces

using neural detectors to interpret action commands, camera-based systems for facial and gaze detection, voice control, and tongue detection. These solutions, however, offer limited action commands, require bulky and invasive equipment (e.g., bulky transducers attached to sensitive organs), are expensive, or require significant computational power. Some of these solutions also require continuous attention by the patient to prevent the patient from moving and talking at the same time.

[0005] Some quadriplegics have more severe injuries (i.e., C1 and C2 injuries), and suffer from difficulty speaking, as well as difficulty moving their head and neck. For these people, the only remaining solutions are using cameras, tongue control, or neural detectors. These technologies have so far been implemented with very limited action commands. Specifically, the action commands are limited to those for controlling the power-driven mobility device itself. These solutions thus do not provide any ability to control devices other than the power-driven mobility device itself, and accordingly these solutions fail to provide quadriplegics with tools for living independently.

[0006] WO 2020/144598 discloses a system with magnetic skin tags and magnetic sensors that determine changes in magnetic fields generated by the magnetic skin tags. There is no discussion of how to use the system to address issues particular to quadriplegics.

[0007] Accordingly, there is a need for a solution for quadriplegics to control movement of a power-driven mobility device, as well as controlling devices other than power-driven mobility devices, without incurring high costs, requiring large computational power, and bulky and invasive equipment.

SUMMARY

[0008] According to an embodiment, there is a system for controlling at least one device. The system includes a pair of glasses comprising a glasses frame. A plurality of magnetic sensors, a processor coupled to the plurality of magnetic sensors, and a wireless communication transmitter coupled to the processor are arranged on or in the glasses frame. A plurality of magnetic skin tags are arranged on a human face. The plurality of magnetic sensors sense movement of at least one of the plurality of magnetic skin tags and transmit a signal corresponding to the sensed movement to the processor. The processor, responsive to receipt of the signal corresponding to the sensed movement, transmits a signal for controlling the at least one device via the wireless communication transmitter to a processor of a power-driven mobility device.

[0009] According to an embodiment, there is a method for controlling at least one device. At least one of a plurality of magnetic sensors arranged on a glasses frame sense a change in a magnetic field due to movement of at least one of a plurality of magnetic skin tags arranged on a human face. A wireless communication transmitter, coupled to or arranged in the glasses frame, transmits a signal corresponding to the sensed change in the magnetic field to a processor of a power-driven mobility device via a wireless communication transceiver of the power-driven mobility device. The processor of the power-driven mobility device determines a command corresponding to the signal. The processor of the power-driven mobility device controls the device based on the determined command.

[0010] According to an embodiment, there is a system for controlling a power-driven mobility device and at least one device. The system includes a pair of glasses comprising a glasses frame, a plurality of magnetic sensors, a processor coupled to the plurality of magnetic sensors, and a wireless communication transmitter coupled to the processor. A plurality of magnetic skin tags are arranged on a human face. The plurality of magnetic sensors are configured to sense movement of at least one of the plurality of magnetic skin tags and transmit a signal corresponding to the sensed movement to the processor. The system also includes a power-driven mobility device comprising a motor, a processor, an interface coupled to the processor and motor, a wireless communication transceiver coupled to the processor, and a wireless communication transmitter coupled to the processor. The processor of the pair of glasses, responsive to receipt of the signal corresponding to the sensed movement, transmits a signal for controlling the power-driven mobility device or the at least one device to the processor of a power-driven mobility device. The at least one device comprises a wireless receiver configured to wirelessly communicate with the wireless communication transmitter of the power-driven mobility device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate one or more embodiments and, together with the description, explain these embodiments. In the drawings:

[0012] Figure 1A is a schematic diagram of a pair of glasses according to embodiments;

[0013] Figure 1B is an illustration of a pair of glasses and magnetic skin tags on a human face according to embodiments;

[0014] Figure 1C is a schematic illustration of circuitry of a pair of glasses according to embodiments;

[0015] Figure 2A is a schematic diagram of a power-driven mobility device according to embodiments;

[0016] Figure 2B is a schematic diagram of circuitry of a power-driven mobility device according to embodiments;

[0017] Figure 3 is a schematic diagram of a system for controlling a device according to embodiments;

[0018] Figures 4A and 4B are flowcharts of a method for controlling at least one device according to embodiments; and

[0019] Figure 5 illustrates the changes in magnetic fields measured by magnetic sensors responsive to moving different portions of a human face.

DETAILED DESCRIPTION

[0020] The following description of the exemplary embodiments refers to the accompanying drawings. The same reference numbers in different drawings identify the same or similar elements. The following detailed description does not limit the invention. Instead, the scope of the invention is defined by the appended claims. The following embodiments are discussed, for simplicity, with regard to the terminology and structure of assistive technology.

[0021] Reference throughout the specification to “one embodiment” or “an embodiment” means that a particular feature, structure or characteristic described in connection with an embodiment is included in at least one embodiment of the subject matter disclosed. Thus, the appearance of the phrases “in one embodiment” or “in an embodiment” in various places throughout the specification is not necessarily referring to the same embodiment. Further, the particular features, structures or characteristics may be combined in any suitable manner in one or more embodiments.

[0022] A system for controlling at least one device will now be described in connection with Figures 1-3, where Figures 1A-1C illustrate components worn on a human face, Figures 2A and 2B illustrate a power-driven mobility device, and Figure 3 illustrates a device other than a power-driven mobility device that can be controlled by facial movements (the device of Figure 3 is also referred to herein as the controlled device and the further device). The system includes a pair of glasses 105, which comprises a glasses frame 110. A plurality of magnetic sensors 115₁-115_x, a processor 120 coupled to the plurality of magnetic sensors 115₁-115_x, and a wireless communication transmitter 125 coupled to the processor 120 are arranged on or in the

glasses frame 110. As illustrated in Figure 1B, a plurality of magnetic skin tags 130₁-130_x are arranged on a human face 135. The plurality of magnetic sensors 115₁-115_x sense movement of at least one of the plurality of magnetic skin tags 130₁-130_x and transmit a signal corresponding to the sensed movement to the processor 120. The processor 120, responsive to receipt of the signal corresponding to the sensed movement, transmits a signal for controlling the at least one device 205 or 300 via the wireless communication transmitter 125 to a processor 210 of a power-driven mobility device 205. In embodiments, the wireless communication transmitter 125 can be a wireless communication transceiver capable of transmitting and receiving wireless signals.

[0023] The plurality of magnetic skin tags 130₁-130_x can be colored to match a user's skin tone, can be colored to be easily visible and identifiable, or can be colored in a manner that would be considered fashionable by the user. The plurality of magnetic skin tags 130₁-130_x can be secured to the face using any technique, such as using a bio-compatible adhesive (e.g., an adhesive that allows the underlying skin to breathe), a petroleum jelly, or any other substance that can secure the plurality of magnetic skin tags 130₁-130_x to a human face that will not irritate the user's skins when worn over a long period of time, such as hours, days, or weeks. Although Figure 1B illustrates the plurality of magnetic skin tags 130₁-130_x as exhibiting an oval shape, the plurality of magnetic skin tags 130₁-130_x can have any shape, and in some implementations can be designed to spell out words, numbers or letters. In other words, the actual shape of the plurality of magnetic skin tags 130₁-130_x is immaterial so

long as the plurality of magnetic skin tags 130₁-130_x produce a sufficient magnetic field, the change of which can be sensed by the plurality of magnetic sensors 115₁-115_x.

[0024] Further, although Figures 1A and 1B respectively illustrate a particular arrangement of the magnetic sensors 115₁-115_x and the magnetic skin tags 130₁-130_x, other arrangements are possible. In the other arrangements, there should be at least a 1-1 relationship between the number of magnetic sensors 115₁-115_x and the number of magnetic skin tags 130₁-130_x (e.g., there can be more than one magnetic sensor to sense changes in magnetic fields of one magnetic skin tag). Additionally, although Figures 1A and 1B respectively illustrate three magnetic sensors 115₁-115_x and three magnetic skin tags 130₁-130_x a greater number or fewer number of magnetic sensors and magnetic skin tags can be employed. Fewer magnetic sensors and magnetic skin tags reduces the number of possible commands and more magnetic sensors and magnetic skin tags increase the number of available commands. Accordingly, the location and number of magnetic skin tags and magnetic sensors can be customized to the needs of the user. For example, if the user does not have much control over his/her nose, then only the forehead magnetic skin tag and a corresponding magnetic sensor can be employed, or alternatively another location on the user's face can be used for the magnetic skin tags that are illustrated as being placed on the user's nose.

[0025] Referring specifically to Figures 1A and 1C, the processor 120 and wireless communication transmitter 125 can be part of the same component or can be separate components. A non-limiting example of a combined processor 120 and wireless communication transmitter 125 is a Bluno Nano chip, which is an Arduino Nano chip with Bluetooth 4.0 functionality. The glasses 105 also include a power

source 145, such as a battery. Alternatively, or additionally, the power source 145 can be any other type of power source, such as a fuel cell, solar panel, etc. Although Figure 1A illustrates the processor 120, wireless communication transceiver 125, and power source 145 being attached to the frame 110, these components can be integrated into the frame 110.

[0026] As illustrated in Figure 1C, the plurality of magnetic sensors 115₁-115_x can be coupled to the processor 120 via a multiplexer 140 and provides measurements of changes in magnetic field in the form of a voltage that corresponds to the magnitude of the change in magnetic field. In a non-limiting example, the multiplexer 140 can be, for example, a PCA9548 octal bidirectional translating switch. It should be recognized, however, that, depending on the processor 120 employed, the multiplexer 140 can be omitted. In the illustrated embodiment, the upper line between the multiplexer 140 and the processor 120/wireless communication transmitter 125 is a data line (e.g., an SCL/SDA line) and the lower line is a power line for conveying power from the battery 145 to the multiplexer 140. Further, the upper line between the magnetic sensors 115₁-115_x is a power line for conveying power from the battery 145 to the magnetic sensors 115₁-115_x and the remaining lines are data lines (e.g., SCL/SDA lines). In one embodiment, the magnetic sensors are BM1422AGMV 3-axis digital magnetometers, which as discussed in more detail below, are configured to sense changes in magnetic field in only one of the three axes. However, other types of magnetic sensors can be employed. Further, the magnetic sensors 115₁-115_x, such as the BM1422AGMV 3-axis digital magnetometers, can be configured to sense changes in magnetic fields in two or all three axes.

[0027] Referring now to Figures 2A and 2B, the power-driven mobility device 205 includes a motor (not visible in the figures) operatively coupled to at least one wheel 220 of the power-driven mobility device 205 to control movement of the power-driven mobility device 205. Although Figure 2A illustrates a wheelchair as the power-driven mobility device, the disclosed embodiments can be employed with other types of power-driven mobility devices, such as electric scooters, golf carts, Segways®, and the like. Thus, consistent with the usage in the art, the term power-driven mobility device should be understood as any mobility device powered by batteries, fuel, or other engines that is used by individuals with mobility disabilities for purposes of locomotion.

[0028] As will be recognized by those skilled in the art, a power-driven mobility device can include a single motor coupled to two or more wheels or a separate motor for each wheel, and in many commercial wheelchairs (as well as electric scooters), motors are coupled to either the front or rear set of wheels (typically the motor is coupled to the larger of the front and rear set of wheels). The power-driven mobility device 205 also includes a wireless communication transceiver 225 coupled to the processor 210. An interface 230 is coupled to the processor 210 and motor. The processor 210 is configured to control movement of the power-driven mobility device 205 using interface 230 based on the signal for controlling the device transmitted from the pair of glasses 105 to the wireless communication transceiver 235 of the power-driven mobility device 205. In one embodiment, which can be used to retrofit an existing power-driven mobility device, the interface 230 is coupled to the controller of the power-driven mobility device's motor. In another embodiment, which can be used

for a power-driven mobility device manufactured with the disclosed equipment, the interface is also the controller of the power-driven mobility device's motor.

[0029] Referring now to Figure 2B, the components of the power-driven mobility device 205 include the processor 210 and wireless communication transceiver 225, which are coupled between a further wireless communication transceiver 235 and digital-to-analog converters 240. In an embodiment, wireless communication transceiver 225 of the power-driven mobility device 205 communicates with the wireless communication transmitter 125 of the pair of glasses 105 using radio frequencies and the power-driven mobility device 205 communicates with a further device 300 (see Figure 3) using line-of-sight communications, such as using visible, near-infrared, or infrared frequencies. If the processor 210 includes digital-to-analog conversion circuitry, the digital-to-analog converters 240 can be omitted. In the illustrated embodiment, the wireless communication transceiver 235 can include a transmitter 235A and a receiver 235B.

[0030] In one non-limiting implementation, the further wireless communication transceiver can communicate using infrared frequencies in the 38 KHz frequency band. In the embodiment illustrated in Figure 2B, the upper line is a data line to the receiver 235B, the lower line is a data line to the transmitter 235A and the middle line is a power line. Similar to the circuitry of the glasses 105, the processor 210 and wireless communication transceiver 225 can be part of the same component or can be separate components, and in a combined implementation a Bluno Nano chip can perform the required functionality of the two components. In the illustrated embodiment, the digital-to-analog converter 240 includes one analog-to-digital converter 240A for providing

commands for controlling forward and backward movement (corresponding to forward and backward movement of the joystick on the power-driven mobility device) and a second analog-to-digital converter 240B for providing commands for controlling left and right movement (corresponding to left and right movement of the joystick on the power-driven mobility device). Depending upon implementation, a single analog-to-digital converter can be employed.

[0031] Figure 3 is a schematic diagram of a system for controlling a device according to embodiments. This controlled device (also referred to herein as the further device) is a device other than the power-driven mobility device, including, but not limited to, a light, a door, a window, an elevator, a television, a set-top box, a pedestrian traffic light, a phone, curtains, doors, or a computer. In other words, the controlled device can be any device requiring physical actions/manipulation that cannot be performed by quadriplegics but can be performed by persons without quadriplegia. The controlled device includes a wireless communication receiver 305 coupled to a processor 310. Similar to the wireless communication transceiver 225, the wireless communication receiver 305 can be a transceiver that includes a transmitter 305A and a receiver 305B, and can communicate, for example, using line-of-sight communications with infrared frequencies, such as the 38 KHz band. However, other frequencies and line-of-sight communication technologies can be used, as desired. Processor 310 is coupled to an interface 315 to the controlled device 320. The interface 315 can include, for example, a digital-to-analog converter, relay, etc. for converting control signals from processor 310 into a format suitable for controlled device 320. Alternatively, the controlled device 320 can be manufactured to operate

with the system, in which case the transceiver and processor of the controlled device 320 itself can be configured in the manner described herein to control the controlled device 320.

[0032] In the embodiment illustrated in Figure 3, the upper line between the wireless communication receiver 305 and processor 310 is a data line to the receiver 305B, the lower line is a data line to the transmitter 305A, and the middle line is a power line. Further, the processor 310 provides power to both the interface 315 and the controlled device 320 using the upper line in Figure 3. The lower line between the processor 310 and the interface 315 provides data commands from processor 310 to interface 315, and the lower line between the interface 315 and the controlled device 320 provides data commands from the interface 315 to the controlled device 320.

[0033] A method for controlling at least one device 205 and/or 300 will now be described in connection with Figure 4A. At least one of a plurality of magnetic sensors 115₁-115_x arranged on a glasses frame 110 senses a change in a magnetic field due to movement of at least one of a plurality of magnetic skin tags 130₁-130_x arranged on a human face 135 (step 405). The changes in magnetic field are conveyed by the plurality of magnetic skin tags 130₁-130_x in the form of a voltage having a magnitude corresponding to the magnitude of the change in the magnetic field. A wireless communication transmitter 125 coupled to or arranged in the glasses frame 110 transmits a signal corresponding to the sensed change in the magnetic field to a processor 210 of a power-driven mobility device 205 via a wireless communication transceiver 225 of the power-driven mobility device 205 (step 410). The processor 210 of the power-driven mobility device 205 determines a command corresponding to the

signal (step 415). The processor 210 of the power-driven mobility device 205 controls the device 205 and/or 300 based on the determined command (step 465).

[0034] Additional details for how the processor 210 of the power-driven mobility device 205 determines a command corresponding to the received signal will now be described in connection with Figure 4B. As will be described below, this method involves the use of a switch command for switching between commands directed to movement of the power-driven mobility device 205 and commands for controlling the further device 300, which is a device other than the power-driven mobility device 205. This is particularly advantageous because it allows the use of the same facial movements to send different commands to the power-driven mobility device 205 and device 300, depending upon the control mode.

[0035] When the processor 210 of the power-driven mobility device 205 receives a command, it determines whether the command is a switch command (step 420). If the command is not a switch command ("No" path out of decision step 420), the processor 210 determines whether the command is a command for the power-driven mobility device (step 425). This determination is based on which control mode is currently active, the control mode being selected by a switch command and/or being defaulted to controlling the power-driven mobility device 205 or the device 300 upon initial powering on. If the command is not for the power-driven mobility device 205 ("No" path out of decision step 425), then the power-driven mobility device 205 controls the device 300, which is also referred to herein as the further device (step 430). This involves the processor 210 sending the command, determined based upon the signal transmitted from the glasses 105, via wireless communication transmitter 235 (which

can be a transceiver), which passes the command to processor 310 for controlling device 320.

[0036] If, however, the command is for the power-driven mobility device (“Yes” path out of decision step 425), then the processor 210 of the power-driven mobility device 205 controls movement of the power-driven mobility device 205 (step 435). Again, this involves the processor 210 sending commands to the interface 230, which can include passing the commands through the digital-to-analog converter 240.

[0037] Returning to step 420, if the processor 210 determines that the received command is a switch command (“Yes” path out of decision step 420), then the processor 210 determines whether the switch is a switch from controlling the power-driven mobility device 205 to controlling the further device 300 (step 440). If the switch is a switch from controlling the device 300 to controlling the power-driven mobility device 205 (“No” path out of decision step 440), then processor 210 switches to power-driven mobility device command mode (step 445) and interprets any future commands, other than a switch command, as being directed to controlling movement of the power-driven mobility device 205. If the switch is a switch from controlling movement of the power-driven mobility device to controlling the device 300 (“Yes” path out of decision step 440), then the processor 210, using wireless communication transmitter 235, searches for the further device 300 (step 450) and the processor 210 determines whether the further device 300 is found (step 455). If the further device 300 is not found (“No” path out of decision step 455), the processor 210 continues to search for the further device 300 (step 450). A time-out value can be defined, if desired, to revert

back to the mode for controlling the power-driven mobility device 205 if the further device 300 is not found at the expiration of the time-out value.

[0038] If, however, the processor 210 determines that the further device 300 is found ("Yes" path out of decision step 455), then the processor 210 switches to a mode for controlling the further device 300 (step 460) and interprets any further commands as being used to control the further device 300. It should be recognized that the switch from the mode controlling movement of the power-driven mobility device 205 to controlling the further device 300 does not occur until the further device 300 is found. Thus, any commands that are received prior to this time (i.e., while the processor 210 searches for the further device 300), will be interpreted as commands for controlling movement of the power-driven mobility device 205. It should be recognized, however, that the switch in command modes to controlling the further device 300 can occur immediately in response to receipt of the switch command, if so desired.

[0039] The delay in the mode switch from controlling the power-driven mobility device 205 to controlling the further device 300 until the further device 300 is particularly advantageous when the power-driven mobility device 205 and further device 300 communicate using line-of-sight communications, such as visible, near-infrared, or infrared frequencies. Specifically, it allows a person to continue to send commands for moving the power-driven mobility device 205 so that the wireless communication transceiver 235 of the power-driven mobility device 205 is aligned with the corresponding wireless communication receiver 305 of the further device 300.

[0040] The use of line-of-sight for communicating between the power-driven mobility device 205 and further device 300 is particularly advantageous over the use of

radio frequencies because line-of-sight communications do not require the robust initialization of the communication connection typically required by most standardized wireless communication techniques that use radio frequencies. Specifically, the line-of-sight communications do not necessarily involve, but could involve if desired, the initial handshaking between devices, as well as the authorization and authentication signaling required by typical radio frequency communication techniques. In contrast, the power-driven mobility device 205 and the glasses 105 are intended to maintain a long-term connection, and thus the additional time for the initial handshaking between the power-driven mobility device 205 and the glasses 105 is not considered to be as much of a concern as with the communication between the power-driven mobility device 205 and the controlled device 300. Further, because the power-driven mobility device 205 acts as a gateway and can be moved based on commands provided by the glasses 105, the additional authorization and authentication of radio frequency communication techniques ensures that movement of the power-driven mobility device 205 is only performed in response to a person authorized to issue such commands.

[0041] Employing the power-driven mobility device 205 as a gateway is also particularly advantageous because a larger processor can be incorporated into the power-driven mobility device 205 without being obtrusive compared to the processor on/in the glasses 105. Further, this reduces the battery consumption of the electronics of the glasses 105, and allows the glasses 105 to operate all of its electronics using a relatively small battery. Thus, the logic for correlating the changes in magnetic fields into commands for controlling the power-driven mobility device 205 and controlled device 300 can be incorporated into the processor 210 of the power-driven mobility

device 205. This correlation can be achieved using any number of techniques, including, for example, using a lookup table correlating measured changes in magnetic fields to commands. The disclosed embodiments can employ any communication technique using radio frequencies. However, it is advantageous from a power consumption perspective to employ a short-range radio technology, such as Bluetooth, including Bluetooth Low Energy (BLE), or Wi-Fi.

[0042] Now that an overview of the system and method have been presented, additional details of the structure and operation of the system are now presented. Returning to Figure 1A, in the illustrated embodiment the plurality of magnetic sensors 115₁-115_x include a magnetic sensor 115₁ arranged on the bridge of the glasses 105, a magnetic sensor 115₂ arranged on the lower left portion of the frames (approximately below the left side of the bridge) and a magnetic sensor 115₃ arranged on the lower right portion of the frames (approximately below the right side of the bridge). An additional magnetic sensor 115_x is arranged in the area of one of the hinges of the glasses 105, which is used as a reference sensor to measure external magnetic noise (e.g., the Earth's magnetic field) so that this noise can be canceled from the magnetic fields sensed from the other magnetic sensors 115₁-115₃. Other locations for the additional magnetic sensor 115_x is at the bottom-left or bottom-right portions of the glasses 105, or any other portion of the glasses 105 that are as far from the intended location of the magnetic skin tags 103₁-130_x.

[0043] Further, as illustrated in Figure 1B the plurality of magnetic skins tags 130₁-130_x includes a magnetic skin tag 130₁ arranged in the glabella of the human face 135, a magnetic skin tag 130₂ arranged on the left side of the nose of the human face

135, and a magnetic skin tag 130_x arranged on the right side of the nose of the human face 135.

[0044] Although the magnetic skin tags 130₁-130_x and magnetic sensors 115₁-115_x can be arranged in different locations than the arrangement illustrated in Figure 1B, this particular arrangement was found to be optimal for avoiding accidental activations (i.e., incorrectly interpreting a facial movement as a command), while still allowing for a particularly easy way to send commands. Specifically, it was found that eyebrow and nose movement is less likely accidentally occur than movement of other locations of the face, such as the cheeks, which move when talking and laughing. In order to further reduce accidental activations, in one embodiment commands require movement of both eyebrows in the same direction, a facial movement that is unlikely to occur accidentally. Accidental activations can also be reduced by employing a threshold for the change in magnetic field to qualify as being an intended gesture.

[0045] It should be recognized that the magnetic sensors 115₁-115_x should be arranged in a predefined relationship with respect to the magnetic skin tags 130₁-130_x in order to properly interpret the change in magnetic fields due to facial movements. In a non-limiting embodiment, the magnetic skin tags 130₁-130_x are magnetized along the z-axis (which is in the vertical direction when a person's head is level with the earth) and should be arranged either above or below the magnetic sensors 115₁-115_x. Similarly, the magnetic sensors 115₁-115_x are configured to be sensitive only to changes in magnetic field in the z-axis. Other orientations are possible so long as the magnetic skin tags 130₁-130_x are magnetized in the direction in which the magnetic

skin tags 130₁-130_x move relative to the magnetic sensors 115₁-115_x for making the facial expressions that correspond to commands.

[0046] A non-limiting example of the changes in magnetic field signals for different facial expressions is illustrated in Figure 5, in which the solid trace represents changes in magnetic fields sensed by the magnetic sensors arranged on the nose and the dashed trace represents changes in magnetic fields sensed by the magnetic sensor on the bridge of the pair of glasses 105. Starting from the left side of the graph, a neutral face is the baseline for measuring changes in magnetic fields, and thus does not produce a change in the magnetic fields sensed by any of the magnetic sensors 115₁-115_x. Moving both eyebrows up causes the magnetic sensor arranged on the bridge of the pair of glasses 105 to sense a negative change in magnetic field and moving both eyebrows down causes the magnetic sensor arranged on the bridge of the pair of glasses 105 to sense a positive change in magnetic field. Moving the nose to the right causes the magnetic sensors arranged on the lower part of the pair of glasses 105 to sense a positive change in magnetic field and moving the nose to the left causes the magnetic sensors arranged on the lower part of the pair of glasses 105 to sense a negative change in magnetic field. In the example illustrated in Figure 5, the changes in magnetic fields sensed by the magnetic sensors arranged in the lower part of the pair of glasses 105 (i.e., the magnetic sensors arranged to sense nose movements) are differential signals, which improves the signal-to-noise ratio of the signal, and thus reduce false positive and false negative interpretations of facial movements as being intended to issue a command. Specifically, the voltage corresponding to the determined change in magnetic field V_{nose} is the difference

between the voltage corresponding to the magnetic field measured for the magnetic skin tag arranged on the right-side of the face V_R and the magnetic skin tag arranged on the left side of the face V_L (i.e., $V_{nose}=V_R-V_L$). Thus, when the nose moves to the right, V_R becomes larger and V_L becomes smaller, and thus V_{nose} is positive. Likewise, when the nose moves to the left, V_R becomes smaller and V_L becomes larger, and thus V_{nose} is negative. It should be recognized that the differential signals can be processed in the opposite manner, i.e., $V_{nose}=V_L-V_R$. As illustrated in Figure 5, because the magnetic skin tags 130₁-130_x are magnetized in the direction of the z-axis, the change in magnetic field that is sensed is due to the slight downward movement of the nose when moving the nose left or right.

[0047] In addition to commands being based on movement of either the glabella or the nose, a combination of movements can be employed as commands. A non-limiting example of movements (which can also be referred to as gestures) and the corresponding comments is illustrated in the following table:

Movement	Command
No expression	Null command (no command issued)
Eyebrows up	Move power-driven mobility device forward or turn further device on
Eyebrows down	Move power-driven mobility device backward or turn further device off
Nose right	Turn power-driven mobility device right or move computer cursor right
Nose left	Turn power-driven mobility device left or move computer cursor left
Eyebrows up and nose right	Turn power-driven mobility device right while still moving forward or move computer cursor diagonally towards the upper right of the screen

Eyebrows up and nose left	Turn power-driven mobility device left while still moving forward or move computer cursor diagonally towards the upper left of the screen
Eyebrows down and nose right	Turn power-driven mobility device right while still moving backward or move computer cursor diagonally towards the lower right of the screen
Eyebrows down and nose left	Turn power-driven mobility device left while still moving backward or move computer cursor diagonally towards the lower left of the screen
Double eyebrows up	No command for power-driven mobility device; Select option for further device to further devices that have selection options
Triple eyebrows up	Mode switch command between mode for controlling power-driven mobility device and mode for controlling further device
Double eyebrows up and nose right	No command for power-driven mobility device; Right-click on computer
Double eyebrows up and nose left	No command for power-driven mobility device; Left-click on computer

[0048] The table above, or a similar table, can be implemented as a look-up table by the processor 210 of the power-driven mobility device 205 by including one or more columns for the voltage values provided by each of the magnetic sensors 115₁-115_x. The correlation between facial movements and commands in the table above is simply one example and other correlations can be employed. Further, double and triple nose movements could be employed to extend the number of available commands.

[0049] As discussed above, the plurality of magnetic skins tags 130₁-130_x are designed to be attached to a human face, and in many cases are intended to be worn for at least a few hours, if not longer. Thus, the plurality of magnetic skins tags 130₁-130_x are designed to be stretchable, flexible, comfortable, and biocompatible. In one

non-limiting embodiment, the plurality of magnetic skins tags 130₁-130_x are comprised of a mixture of a silicon-based elastomer matrix (e.g., material sold under the name Ecoflex by Smooth-On) with a permanent magnetic powder (e.g., NdFeB) with a 1:1 weight ratio. It was found that this weight ratio offers the best combination of high remanent magnetization and high flexibility. Specifically, this weight ratio produced a magnetic skin tag having a Yong's modulus of 129 kPa, which is more than 17 times lower compared to conventional Sylgard-based magnetic composites, which have a Young's modulus greater than 2,200 kPa. The ultra-low Young's modulus of the magnetic skins tags 130₁-130_x makes the presence of the magnetic skin tags almost imperceptible to the wearer. A magnetic skin tag with the 1:1 weight ratio noted above and having dimensions of 10x2x.07 mm³ exhibited a magnetic flux density of 177 μ T at a distance of 7 mm, which provides a sufficient magnetic field for detection by the magnetic sensors with a good signal-to-noise ratio. A magnetic skin tag with the 1:1 weight ratio noted above was subject to stress testing, which demonstrated that the magnetic skin tag maintained its properties over 1000 stress cycles, each cycle involving stretching the magnetic skin tag from its normal length to 180% percent of its normal length and then relaxing the magnetic skin tag to 50% of its normal length. Biocompatibility of the magnetic skin tag with the 1:1 weight ratio noted above was demonstrated using a PrestoBlue cell viability test, where the cells maintained a high viability (i.e., > 90%) when cultured on top of the magnetic skin tag for three days.

[0050] Because the magnetic skin tags are designed to be worn for extended periods of time, the magnetic skin tags will become uncomfortable unless they are breathable, which can suppress irritations and other feelings of discomfort that might

arise from wearing a magnetic skin tag. According to one non-limiting embodiment, breathability is achieved by introducing micro-holes in the magnetic skin tag. For example, after preparing the magnetic skin tag using the 1:1 weight ratio noted above, micro-holes having a diameter of, for example, 70 μm are formed using a 30 W ytterbium fiber laser with a 1.06 μm wavelength. In one embodiment, the magnetic skin tag has a hole density of up to 2,500 holes/ cm^2 , which is four times the density of human sweat glands. Even with the presence of these micro-holes, it was found that a magnetic skin tag that was 0.1 mm thick and had 1,250 holes/ cm^2 could withstand more than 300% elongation and exhibited a coercivity of 560 mT, which is the required external field to demagnetize the magnetic skin tags. The remanent magnetization is the magnetic field embedded in the magnetic skin tags after being magnetized along the z-axis. In one embodiment, a magnetic skin tag, without any holes, with the 1:1 weight ratio exhibited a remanent magnetization of 126 mT.

[0051] Testing showed that the magnetic field drops approximately 20% for every added 1,250 holes/ cm^2 (or about 1% per 62 holes). Because breathability is characterized by the water vapor transmission rate (WVTR), which is a measure of the vapor permeability of a substrate, the WVTR of the magnetic skin tag with different hole densities were tested and the highest WVTR was found to be $95 \times 10^3 \text{ g} \cdot \text{m}^{-2} \cdot \text{day}^{-1}$ (with a hole density of approximately 2,500 holes/ cm^2 , which is about two orders of magnitude higher than the range of 200-500 $\text{g} \cdot \text{m}^{-2} \cdot \text{day}^{-1}$ of human skin. The WVTR testing also found that a magnetic skin tag with a hole density of 1,250 holes/ cm^2 offers a high breathability of $60 \times 10^3 \text{ g} \cdot \text{m}^{-2} \cdot \text{day}^{-1}$ while reducing the magnetic field by only 20% compared to the magnetic field without any holes.

[0052] Although embodiments discussed above involve using the processor of the power-driven mobility device as a gateway for sending commands between the glasses and a further device, it should be recognized that further embodiments can omit the power-driven mobility device as a gateway and allow the glasses to send commands directly to a further device. This can be achieved using radio frequency communications and/or line-of-sight communications. When only line-of-sight communications are employed, the glasses can omit the radio frequency transmitter (or transceiver) and include a line-of-sight transmitter (or transceiver), and when only radio frequency communications are employed, the glasses can use the disclosed transmitter (or transceiver) to communicate with the further device using radio frequencies.

[0053] As will be appreciated from the discussion above, the disclosed embodiments provide a cost-effective solution for assisting quadriplegics and others with physical disabilities for operating a power-driven mobility device and other devices that does not involve complicated, invasive and bulky equipment, and does not require a large amount of processing power. Accordingly, the disclosed embodiments provide a particularly advantageous system for controlling power-driven mobility devices and other devices.

[0054] The disclosed embodiments provide a system for controlling devices, including power-driven mobility devices and devices other than power-driven mobility devices, using facial movements. It should be understood that this description is not intended to limit the invention. On the contrary, the exemplary embodiments are intended to cover alternatives, modifications and equivalents, which are included in the

spirit and scope of the invention as defined by the appended claims. Further, in the detailed description of the exemplary embodiments, numerous specific details are set forth in order to provide a comprehensive understanding of the claimed invention. However, one skilled in the art would understand that various embodiments may be practiced without such specific details.

[0055] Although the features and elements of the present exemplary embodiments are described in the embodiments in particular combinations, each feature or element can be used alone without the other features and elements of the embodiments or in various combinations with or without other features and elements disclosed herein.

[0056] This written description uses examples of the subject matter disclosed to enable any person skilled in the art to practice the same, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the subject matter is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims.

WHAT IS CLAIMED IS:

1. A system for controlling at least one device (205, 300), the system comprising:

a pair of glasses (105) comprising a glasses frame (110), wherein a plurality of magnetic sensors (115₁-115_x), a processor (120) coupled to the plurality of magnetic sensors (115₁-115_x), and a wireless communication transmitter (125) coupled to the processor (120) are arranged on or in the glasses frame (110);

a plurality of magnetic skins tags (130₁-130_x) arranged on a human face (135),

wherein the plurality of magnetic sensors (115₁-115_x) sense movement of at least one of the plurality of magnetic skin tags (130₁-130_x) and transmit a signal corresponding to the sensed movement to the processor (120), and

wherein the processor (120), responsive to receipt of the signal corresponding to the sensed movement, transmits a signal for controlling the at least one device (205, 300) via the wireless communication transmitter (125) to a processor (210) of a power-driven mobility device (205).

2. The system of claim 1, wherein the at least one device is the power-driven mobility device, which comprises:

a motor operatively coupled to at least one wheel of the power-driven mobility device to control movement of the power-driven mobility device;

a wireless communication transceiver coupled to the processor; and

an interface coupled to the processor and motor, wherein the processor is configured to control movement of the power-driven mobility device based on the signal for controlling the device transmitted to the wireless communication transceiver of the power-driven mobility device.

3. The system of claim 2, wherein the at least one device includes a further device, which comprises a wireless communication receiver, wherein the power-driven mobility device includes a further wireless communication transceiver coupled to the processor of the power-driven mobility device, and the processor of the power-driven mobility device is configured to transmit, via the further wireless communication transceiver, a further signal for controlling the further device.

4. The system of claim 3, wherein the wireless communication transceiver of the power-driven mobility device and the wireless communication transmitter of the pair of glasses operate using radio frequencies, and wherein the further wireless communication transceiver and the wireless communication transceiver of the device operate using line-of-sight communications.

5. The system of claim 1, wherein
the at least one device is a further device,
the further device is a device other than the power-driven mobility device,
the power-driven mobility device comprises

a wireless communication transceiver coupled to the processor of the power-driven mobility device, the wireless communication transceiver configured to communicate with the wireless communication transmitter of the pair of glasses, and

a further wireless communication transmitter coupled to the processor of the power-driven mobility device, wherein the further wireless communication transmitter is configured to transmit, to the further device, a signal for controlling the further device.

6. The system of claim 5, wherein the further device is a light, a door, a window, an elevator, a television, a set-top box, a pedestrian traffic light, a phone, curtains, doors, or a computer.

7. The system of claim 1, wherein

the plurality of magnetic skin tags comprise first and second magnetic skin tags arranged on opposite sides of a nose of the human face, and a third magnetic skin tag arranged on a forehead of the human face, and

the plurality of magnetic sensors of the pair of glasses include a first magnetic sensor arranged on a bridge of the pair of glasses, and a second and third magnetic sensor arranged on opposite rims of the pair of glasses.

8. The system of claim 7, wherein the plurality of magnetic sensors comprise a fourth magnetic sensor, which is arranged next to a hinge of the pair of glasses, in a

bottom-left portion of the pair of glasses, or in a bottom-right portion of the pair of glasses, wherein the fourth magnetic sensor is a reference sensor.

9. The system of claim 1, wherein the plurality of magnetic skin tags are comprised of a mixture, in equal parts, of a silicon-based elastomer matrix and a magnetic powder.

10. The system of claim 9, wherein each of the plurality of magnetic skin tags include a plurality of perforations configured to allow skin of the human face covered by the magnetic skin tags to pass water vapor through the respective one of the plurality of magnetic skin tags.

11. A method for controlling at least one device (205, 300), the method comprising:

sensing (405), by at least one of a plurality of magnetic sensors (115₁-115_x) arranged on a glasses frame (110), a change in a magnetic field due to movement of at least one of a plurality of magnetic skin tags (130₁-130_x) arranged on a human face (135);

transmitting (410), by a wireless communication transmitter (125) coupled to or arranged in the glasses frame (110), a signal corresponding to the sensed change in the magnetic field to a processor (210) of a power-driven mobility device (205) via a wireless communication transceiver (225) of the power-driven mobility device (205);

determining (415), by the processor (210) of the power-driven mobility device (205), a command corresponding to the signal; and
controlling (465), by the processor (210) of the power-driven mobility device (205), the device (205, 300) based on the determined command.

12. The method of claim 11, wherein
the at least one device is the power-driven mobility device,
the command is a movement command for moving the power-driven mobility device,
the controlling of the power-driven mobility device based on the movement command comprises sending, by the processor of the power-driven mobility device, a signal to an interface of the power-driven mobility device, and
the interface of the power-driven mobility device is coupled to a motor of the power-driven mobility device and is configured to control movement of the power-driven mobility device using the motor.

13. The method of claim 11, wherein
the at least one device is a further device, which is a device other than the power-driven mobility device,
the command is a control command for controlling the further device,
the controlling of the further device based on the control command by the processor of the power-driven mobility device comprises sending, via a further

wireless transmitter of the power-driven mobility device, the control command to the further device using line-of-sight communications.

14. The method of claim 13, further comprising:

receiving, by the processor of the power-driven mobility device from the wireless communication transmitter coupled to or arranged in the glasses frame, a switch command prior to receiving the command corresponding to the signal;

searching, responsive to receipt of the switch command, for a further device, which is a device other than the power-driven mobility device; and

transmitting, by the processor of the power-driven mobility device, additional commands to the further device once the further device is located,

wherein signals corresponding to commands that are received by the processor of the power-driven mobility device prior to locating the further device are used to control movement of the power-driven mobility device.

15. The method of claim 11, wherein the sensed change in magnetic field is due to a movement of at least one eyebrow or a nose of the human face.

16. A system for controlling a power-driven mobility device (205) and at least one device (300), the system comprising:

a pair of glasses (105) comprising a glasses frame (110), a plurality of magnetic sensors (115₁-115_x), a processor (120) coupled to the plurality of magnetic

sensors (115₁-115_x), and a wireless communication transmitter (125) coupled to the processor (120);

a plurality of magnetic skins tags (130₁-130_x) arranged on a human face (135), wherein the plurality of magnetic sensors (115₁-115_x) are configured to sense movement of at least one of the plurality of magnetic skin tags (130₁-130_x) and transmit a signal corresponding to the sensed movement to the processor (120); and

a power-driven mobility device (205) comprising a motor, a processor (210), an interface (230) coupled to the processor (210) and motor, a wireless communication transceiver (225) coupled to the processor (210), and a wireless communication transmitter (235) coupled to the processor (210), wherein the processor (120) of the pair of glasses (105), responsive to receipt of the signal corresponding to the sensed movement, transmits a signal for controlling the power-driven mobility device (205) or the at least one device (300) to the processor (210) of a power-driven mobility device (205),

wherein the at least one device (300) comprises a wireless receiver (305) configured to wirelessly communicate with the wireless communication transmitter (235) of the power-driven mobility device (205).

17. The system of claim 16, wherein the wireless communication transmitter of the pair of glasses and the wireless communication transceiver of the power-driven mobility device communicate using a first communication technique, and wherein the wireless communication transmitter of the power-driven mobility device and the

wireless communication receiver of the at least one device communicate using a second communication technique.

18. The system of claim 16, wherein the first communication technique uses radio frequencies and the second communication technique uses line-of-sight communications.

19. The system of claim 16, wherein the at least one device is a light, a door, a window, an elevator, a television, a pedestrian traffic light, a phone, curtains, doors, or a computer.

20. The system of claim 16, wherein
the plurality of magnetic skin tags comprise first and second magnetic skin tags arranged on opposite sides of a nose of the human face, and a third magnetic skin tag arranged on a forehead of the human face, and
the plurality of magnetic sensors of the pair of glasses include a first magnetic sensor arranged on a bridge of the pair of glasses, and a second and third magnetic sensor arranged on opposite rims of the pair of glasses.

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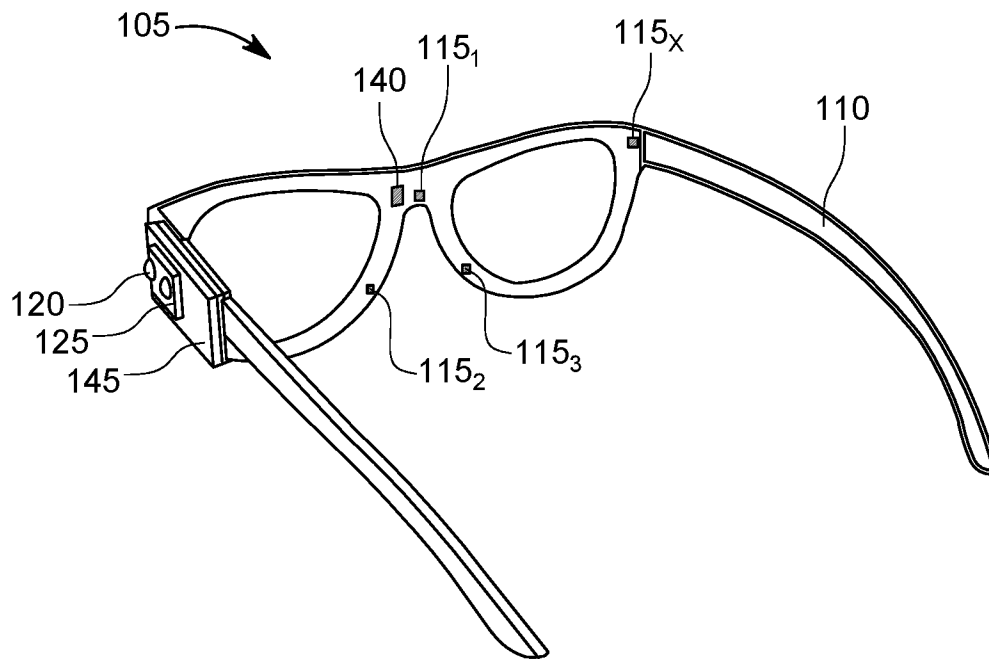


FIG. 1A

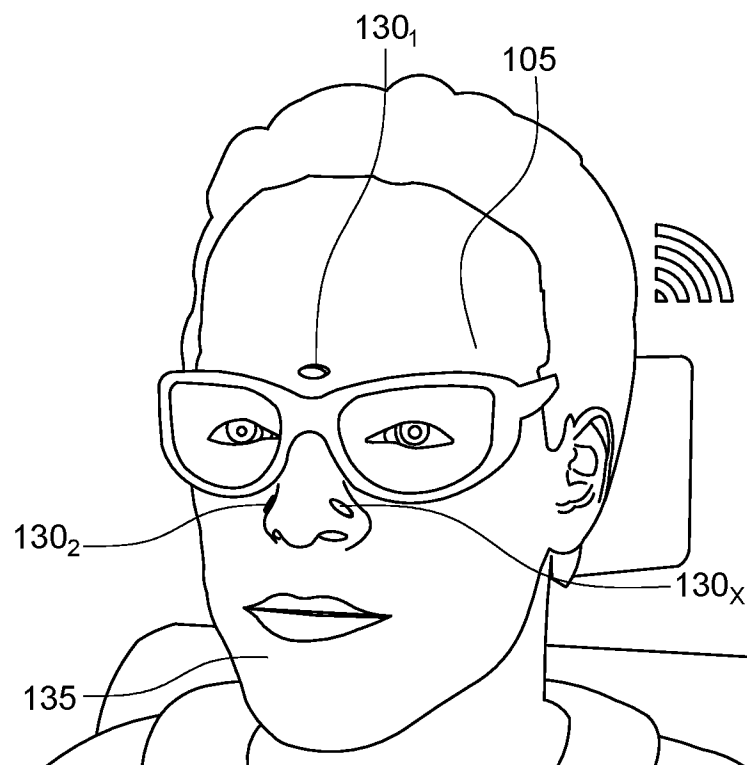


FIG. 1B

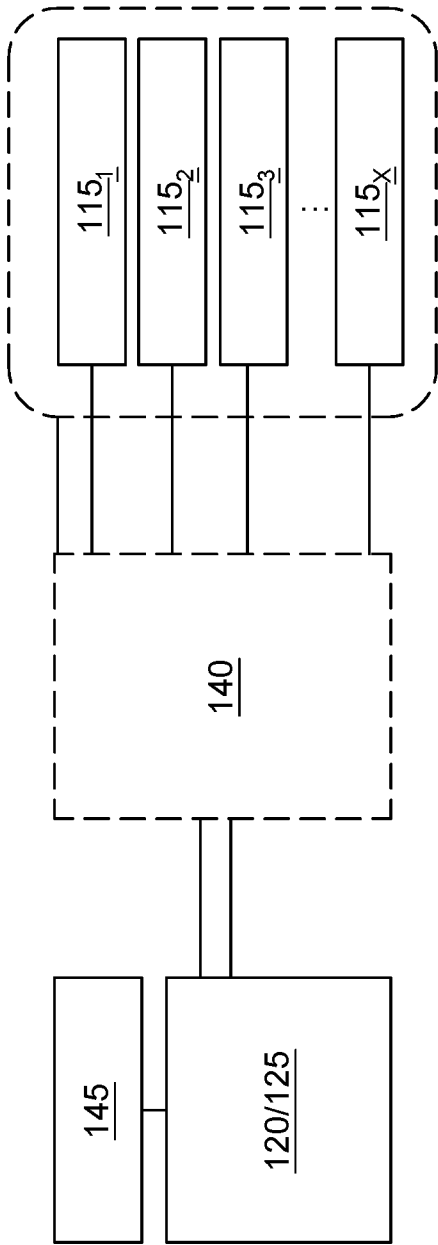


FIG. 1C

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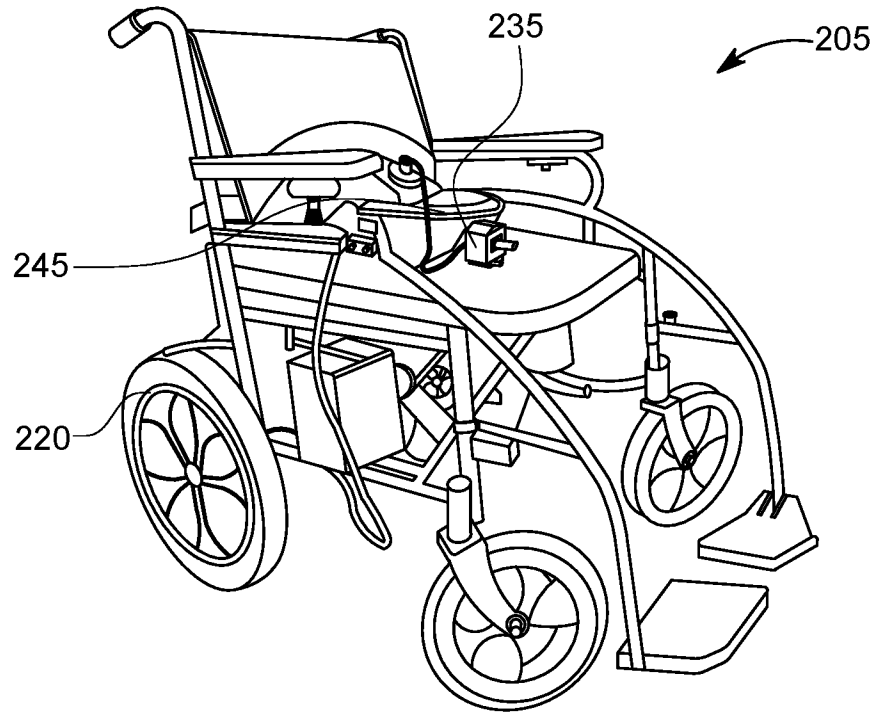


FIG. 2A

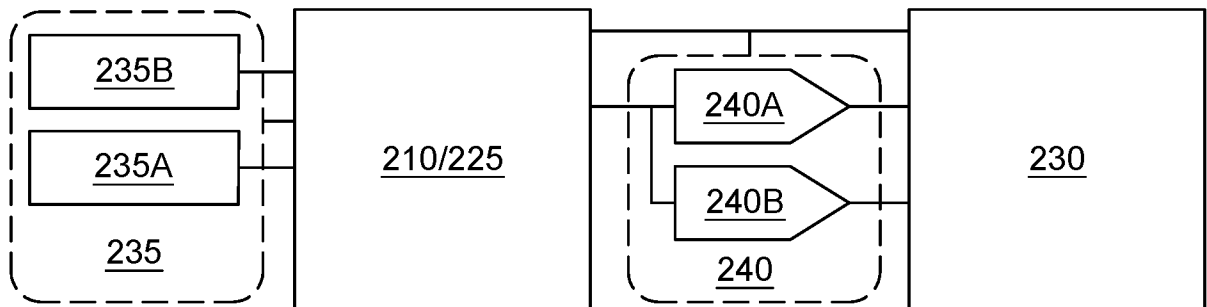


FIG. 2B

300

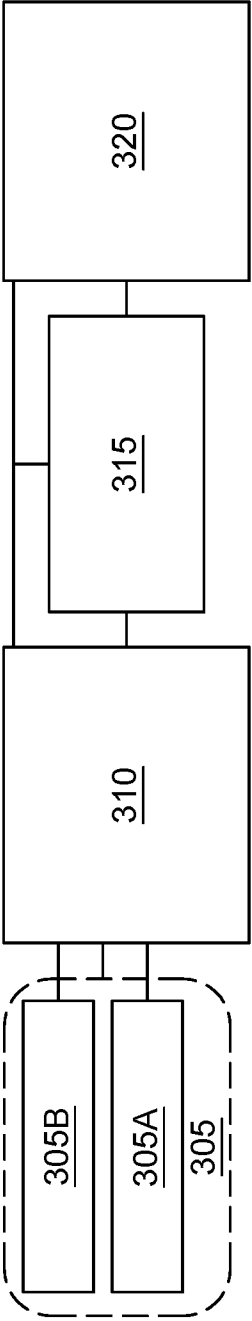


FIG. 3

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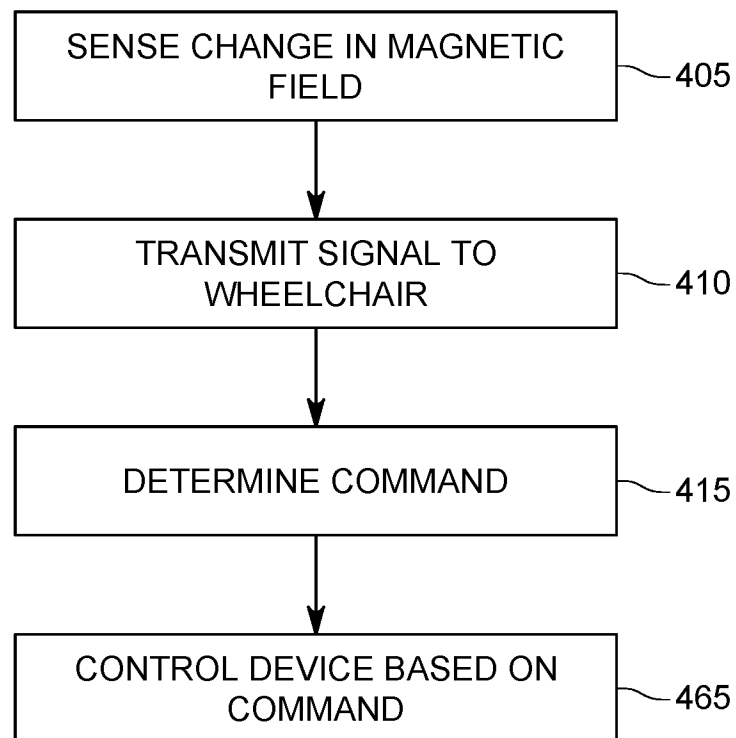


FIG. 4A

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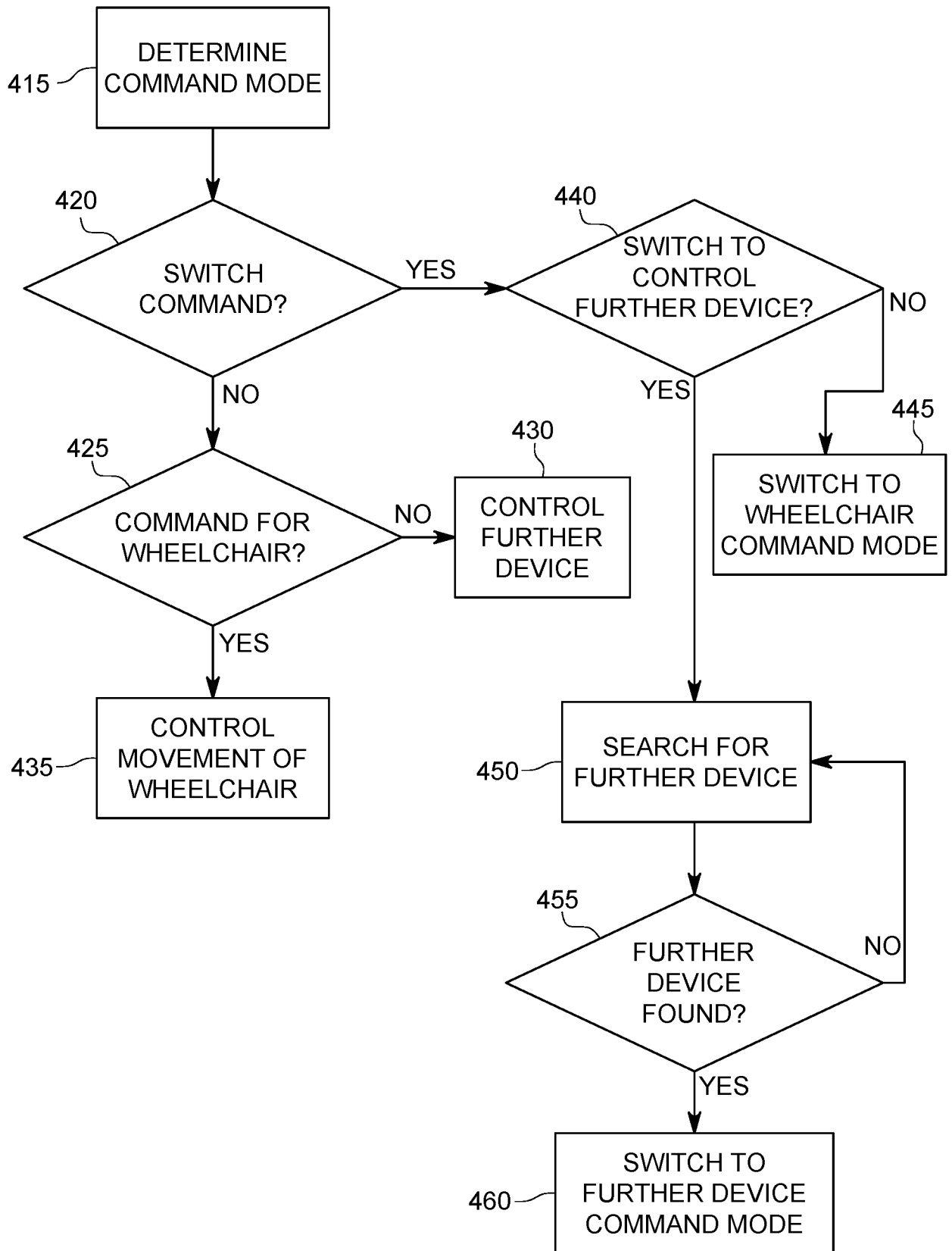


FIG. 4B

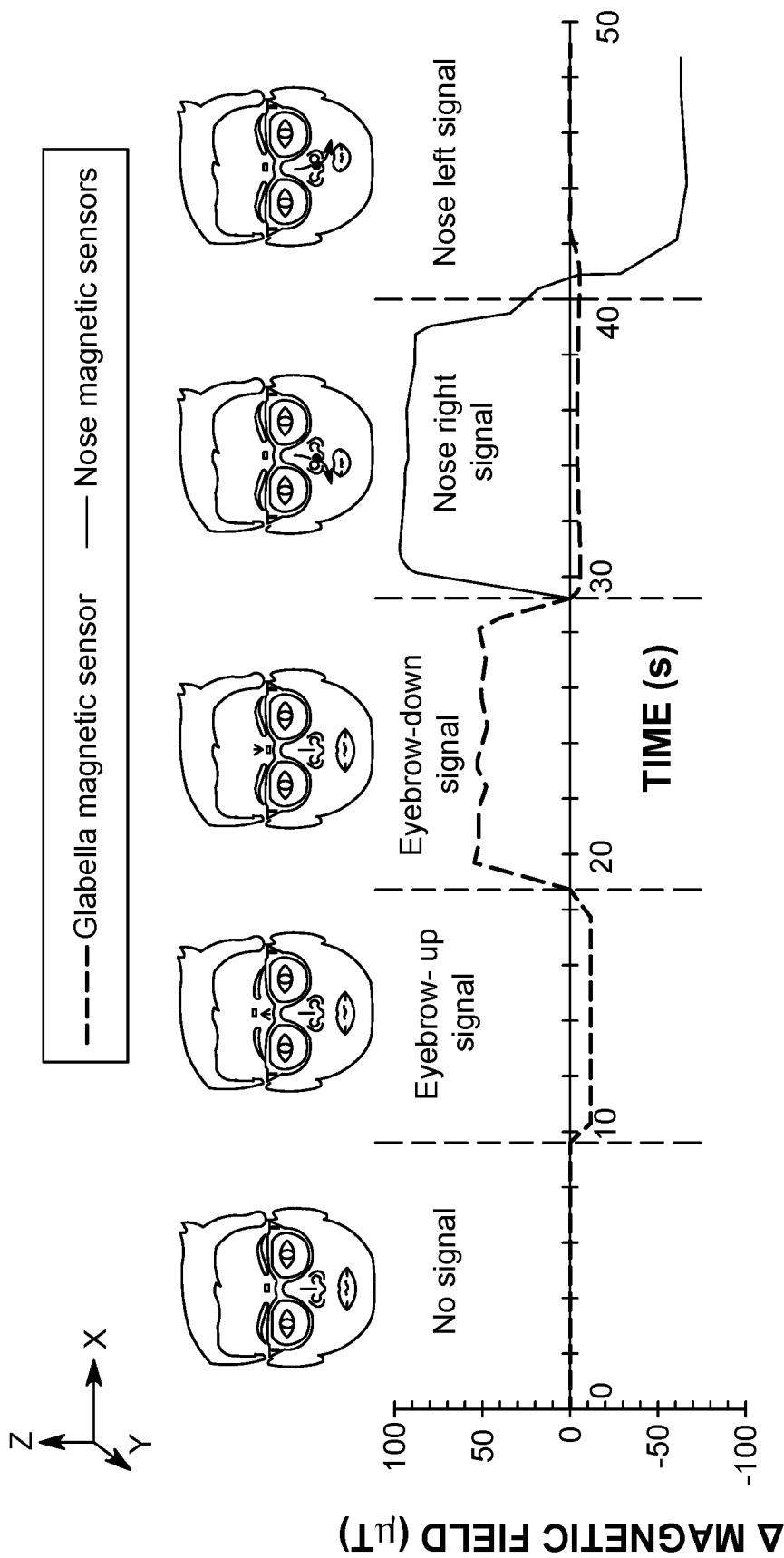


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2020/057279

A. CLASSIFICATION OF SUBJECT MATTER

INV. G06F3/01

MATTER
A61G5/04

A61B5/06

A61B5/00

A61F4/00

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06F A61G A61B A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/281181 A1 (CHEN RUXIN [US] ET AL) 8 November 2012 (2012-11-08)	1-6, 11-19
A	figures 1-21 paragraph [0036] - paragraph [0054] paragraph [0065] - paragraph [0087] paragraph [0099] - paragraph [0112] -----	7,8,20
A	US 2013/090931 A1 (GHOVANLOO MAYSAM [US] ET AL) 11 April 2013 (2013-04-11) figures 1-11 paragraph [0003] - paragraph [0031] paragraph [0049] - paragraph [0116] -----	1-8, 11-20
A	US 2009/309747 A1 (GHOVANLOO MAYSAM [US] ET AL) 17 December 2009 (2009-12-17) figures 1-44D paragraph [0003] - paragraph [0021] paragraph [0076] - paragraph [0337] -----	1-8, 11-20
	-/--	

X

Further documents are listed in the continuation of Box C.

X

See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

20 October 2020

Date of mailing of the international search report

21/12/2020

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2

NL - 2280 HV Rijswijk

Tel. (+31-70) 340-2040,

Fax: (+31-70) 340-3016

Authorized officer

Roth, Lucia

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2020/057279

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	XUELIANG HUO ET AL: "A Wireless Tongue-Computer Interface Using Stereo Differential Magnetic Field Measurement", 2007 ANNUAL INTERNATIONAL CONFERENCE OF THE IEEE ENGINEERING IN MEDICINE AND BIOLOGY SOCIETY : [EMBC '07] ; LYON, FRANCE, 22 - 26 AUGUST 2007 ; [IN CONJUNCTION WITH THE BIENNIAL CONFERENCE OF THE SOCIÉTÉ FRANÇAISE DE GÉNIE BIOLOGIQUE ET MÉDICAL (SFGB, 22 August 2007 (2007-08-22), pages 5723-5726, XP031337525, ISBN: 978-1-4244-0787-3 page 5723, left-hand column, line 1 - page 5726, right-hand column, line 2 figures 1-3 -----	1-8, 11-20
A	CN 104 331 160 A (UNIV CHONGQING POSTS & TELECOM) 4 February 2015 (2015-02-04) figures 1-4 paragraph [0002] - paragraph [0003] -----	1-8, 11-20
A	CN 108 272 566 A (UNIV ZHENGZHOU) 13 July 2018 (2018-07-13) figures 1-3 paragraph [0001] - paragraph [0030] paragraph [0036] - paragraph [0040] -----	1-8, 11-20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2020/057279

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-8, 11-20

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-8, 11-20

Arranging magnetic skin tags on a user's face and corresponding sensors on a glasses frame.

2. claims: 9, 10

Providing a material composition for magnetic flexible skin tags.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2020/057279

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012281181 A1	08-11-2012	CN 103649874 A	19-03-2014
		CN 105640489 A	08-06-2016
		US 2012281181 A1	08-11-2012
		US 2014198382 A1	17-07-2014
		WO 2012151538 A2	08-11-2012

US 2013090931 A1	11-04-2013	NONE	

US 2009309747 A1	17-12-2009	NONE	

CN 104331160 A	04-02-2015	NONE	

CN 108272566 A	13-07-2018	NONE	
